Predictors of a Healthy Eating Disorder Examination-Questionnaire (EDE-Q) Score 1 Year After Bariatric Surgery

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Abstract: BACKGROUND: Bariatric surgery (BS) has been shown to ameliorate health-related quality of life and eating disorder symptoms. However, the correlation of these changes with weight loss is not uniform, suggesting that additional factors have an impact on postoperative outcomes. OBJECTIVE: To assess the impact of BS on eating disorder symptoms at 1 year postoperatively and to generate predictive models for the achievement of optimal eating behavior. METHODS: Retrospective cohort study on a prospectively collected database of all consecutive patients who underwent primary BS in our academic center between January 2015 and March 2017. Eating Disorder Examination-Questionnaire (EDE-Q) was used to measure eating psychopathology. Logistic regression was used to estimate the odds ratio of achieving "healthy" EDE-Q at 1 year. Missing data was handled by multiple imputations for the regression model. RESULTS: Two-hundred thirty-four patients were included. A complete-case analysis in 135 cases showed a "healthy" EDE-Q in 27.4% at baseline and in 83.7% at 1 year (difference = 56.3%, P = 0.018). Only the baseline EDE-Q "healthy" status influenced significantly the odds of achieving "healthy" EDE-Q at 1 year (OR 6.7, 95% CI 1.18-38.14, P = 0.04). CONCLUSION: BS seems to promote successful treatment of self-reported eating disorder symptoms during the first postoperative year. The achievement of optimal results is independent of age, sex, weight loss, obesity-related comorbidity status, surgical technique, or 30-day surgical complications. Future studies, using validated questionnaires specifically designed to investigate eating behavior after BS and/or direct measurements of the eating behavior are needed to clarify the underlying neuropsychologic mechanisms that drive the observed postoperative changes.

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Abstract

Background

Bariatric surgery (BS) has been shown to ameliorate health-related quality of life and eating disorder symptoms. However, the correlation of these changes with weight loss is not uniform, suggesting that additional factors have an impact on post-operative outcomes.

Objective

To assess the impact of BS on eating disorder symptoms at 1-year postoperatively, and to generate predictive models for the achievement of optimal eating behavior.

Methods

Retrospective cohort study on a prospectively collected database of all consecutive patients who underwent primary BS in our academic center between 01/2015-03/2017. Eating Disorder Examination-Questionnaire (EDE-Q) was used to measure eating psychopathology. Logistic regression was used to estimate the odds ratio of achieving "healthy" EDE-Q at 1-year. Missing data was handled by multiple imputations for the regression model.

Results

Two-hundred-thirty-four patients were included. A complete-case analysis in 135 cases showed a "healthy" EDE-Q in 27.4% at baseline and in 83.7% at 1-year (difference = 56.3%, P = 0.018). Only the baseline EDE-Q "healthy" status influenced significantly the odds of achieving "healthy" EDE-Q at 1-year (OR 6.7, 95% CI 1.18 – 38.14, P = 0.04).

Conclusion

BS seems to promote successful treatment of self-reported eating disorder symptoms during the first postoperative year. The achievement of optimal results is independent of age, sex, weight-loss, obesity-related comorbidity status, surgical technique or 30-day surgical complications. Future studies, using validated questionnaires specifically designed to investigate eating behavior after BS and/or direct measurements of the eating behavior are needed to clarify the underlying neuropsychologic mechanisms that drive the observed postoperative changes.

Key words Eating Disorder Examination Questionnaire, Eating Behavior, Bariatric surgery, Excess weight loss, Predictors of outcome, Roux-en-Y gastric bypass

Introduction

Most studies using models to predict outcomes of bariatric surgery (BS) strived to identify predictors of successful weight loss [1-5]. However, modern concepts in BS relativize the role of weight loss as single criterion of postbariatric success, and advocate offering BS preferably to patients with complications of obesity that would be expected to be resolved postoperatively [6, 7]. Screening tools to identify individuals who may benefit the most from BS need to be improved accordingly. Along these lines, *Wood et Ogden* suggested that recognition of factors that may predict the normalization of pathologic eating behaviors could represent another basis of improving patient selection for BS [8].

Patients tend to report lower level of baseline hunger, less frequent emotional eating and faster intra-meal satiation following BS [9]. In addition, BS seems to induce changes in food preferences, with a shift from high-fat high-sugar nutrients to a less calorie-dense diet [10, 11], which has been recently hypothesized to beneficially influence postbariatric eating behavior [12]. Overall, BS has a beneficial effect on health-related quality of life and eating disorder symptoms, however, the correlation of these improvements with postoperative weight loss is

not uniform [9, 11, 13, 14]. This suggests that additional factors may have an impact on the postbariatric amelioration of eating disorders.

Therefore, this study aimed to assess the prevalence of self-reported eating disorders symptoms before and at 1-year after BS by using the Eating Disorder Examination-Questionnaire (EDE-Q), and to generate predictive models for the achievement of optimal eating behavior in an explorative way, including demographic and health-related variables.

Methods

Participants

A retrospective cohort study was performed on a prospectively collected database of all consecutive patients who had sufficient German language skills and underwent primary laparoscopic BS (Roux-en-Y gastric bypass [RYGB] or sleeve gastrectomy [SG]) in our tertiary referral center from January 2015 to March 2017. Data-analysis was performed in September 2018. According to the national guidelines of the Swiss Society for the Study of Morbid Obesity and Metabolic Disorders (SMOB), patients were eligible for surgery if they were aged over 18, had a BMI $\geq$ 40 kg/m^2 or BMI $\geq$ 35 kg/m^2 with obesity-related comorbidities, and had a two year history of failed conservative attempts to achieve sustained weight loss [15]. All patients were evaluated and prepared by a multidisciplinary team specialized in the management of severely obese individuals. Data are reported in accordance with the STROBE guidelines [16].

Measurements

Data collection was prospective, took place at the outpatient visits, and included age, sex, objective BMI measurement, percentage of excess BMI loss (%EBMIL, with BMI = 25 considered ideal) [17], hip and waist measurements, comorbidities and surgical complications according to the Clavien-Dindo classification [18].

The German translation of the EDE-Q [19] was used to measure eating disorder psychopathology as part of the regular preoperative evaluation. Patients filled in the EDE-Q alone at the outpatient clinic, with a physician at disposal in case of need. The questionnaire was administered again at the 1-year follow-up visit, however, patients were then allowed to bring the questionnaire home and send it back by mail. EDE-Q has well-established psychometric properties and has been validated in German cohorts [20]. The EDE-Q focuses on the previous 28 days and measures key eating disorder behavior- and cognitive symptoms. The questions are rated on a 7-point Likert scale from 0–6, where a higher score indicates increased frequency of eating disorder symptoms. The EDE-Q consists of one total score and four subscales (restraint, eating concern, weight concern and shape concern). Cut-off is defined in normal weight populations as mean total EDE-Q score plus one standard deviation which is approximately 2.5–2.8, depending on different normative samples [21, 22]. In the current study, a threshold of < 2.5 was used to define absence of eating disorders and to dichotomize total EDE-Q outcomes to "healthy" and "unhealthy" subgroups.

Statistics

Demographic and clinical characteristics were presented as means and standard deviations (SD) or frequencies and percentages. Effect size for continuous variables was expressed as Cohen's d, and for binary variables as odds ratios [23]. Cronbach's alpha was used to measure internal consistency of the EDE-Q. Statistical testing was performed by a) paired t-test to assess changes from baseline to 1-year in continuous variables, b) by independent sample t-test for subgroup outcomes for continuous variables and c) by Wilcoxon rank sum tests with continuity correction for changes in categorical variables. Baseline characteristics of patients with and without available 1-year EDE-Q scores were compared to identify specific traits that might be overrepresented in patients lost to follow-up. A complete case analysis was used for descriptive statistics. Logistic regression was used to estimate the odds ratio with a 95% confidence interval

of different parameters that might influence the postoperative total EDE-Q score, dichotomized to "healthy" or "unhealthy" outcomes. Based on recent studies, BMI, %EBMIL (grouped into four categories: ≤50%, 50-75%, 75-100% and >100%) [24], existence and persistence of co-morbidities[25], age (grouped into three categories: ≤30, 30-50 and >50 years) and sex were considered potential predictors of EDE-Q and were included in the analysis [26]. Other possible causal variables included in the calculation were as follows: type of procedure (RYGB or SG), presence or absence of any surgical complication during the 1st month, and baseline total EDE-Q score (dichotomized to "healthy"/"unhealthy"). Assuming that missing data in the 1-year EDE-Q scores occurred at random, five series of multiple imputations, using baseline and postbaseline variables selected for the regression model, were performed with the R package "mice" [27, 28]. The m=5 imputed datasets were combined for the logistic regression model according to Rubin's formula [29].

Statistical tests were two-tailed and $P < 0.05$ was considered significant. Analyses were performed using R software version 3.5.1 (The R foundation for Statistical Computing, Vienna, Austria).

Results

Study population

The institutional database contained 234 cases of primary BS with available EDE-Q scores at baseline. Among those patients, 202 had a 1-year follow-up visit and 135 completed the EDE-Q at 1-year. There was no available information regarding the reasons of dropouts at 1-year. There were no differences in baseline characteristics of patients with and without 1-year EDE-Q follow-up (Supplemental Digital Content 1). Table 1 summarizes the characteristics of the study cohort available for complete-case analysis. Females were overrepresented in the study population (71.8%), the mean age was 40.3 ± 12.1 years and the mean BMI 43.97 ± 6.5 kg/m^2. Significant decreases in body weight and BMI were recorded. The 1-year %BMI loss was 32.4

± 9% (range: 9.1 – 50.9) and the %EBMIL was 79.9 ± 23.6% (range: 19.6 – 149.8). The 30-day surgical complications according to the Clavien-Dindo classification are presented in Table 2. Overall, 28.15% of patients presented a complication (defined as any deviation from the normal postoperative course [18]), although only 2.2% required a re-operation due to a complication and the 30-day mortality was null. Of note, between the 2nd and the 12th month, six patients (4.4%) underwent re-operation for internal hernia.

Self-reported eating pathology symptoms

The EDE-Q had a high internal consistency both at baseline and at 1-year (Cronbach's $\alpha = 0.86$ and 0.85, respectively). Overall, EDE-Q scores decreased significantly in total (Figure 1) and for each subscale (Table 3). The total EDE-Q score of the participants was "healthy" in 27.4% of cases at baseline and in 83.9% at 1-year (difference = 56.3%, P = 0.018). There was a highly significant improvement in each individual EDE-Q question, except for EDE-Q-16 (P = 0.837) and EDE-Q-18 (P = 0.197). These questions consisted of the frequency of self-induced vomiting and compulsive exercise for weight/shape control. Most patients never engaged in such behavior at baseline (95.6% and 74.5%, respectively), which gave almost no room for significant improvement by 1-year postoperatively.

Subgroup analyses based on sex, age-groups and %EBMIL showed no clinically relevant differences in baseline or 1-year EDE-Q total and subscale outcomes (Supplemental Digital Content 2). Patients who achieved >75% EBMIL at 1-year had a lower EDE-Q total score (1.25 vs. 1.64, 95% CI of difference in means: 0.065 to 0.714, P = 0.019), however, the mean value of both subgroups (%EBMIL ≤ or > 75%) was in the healthy range.

Correlations of eating disorders with BMI, EBMIL and age

The correlations between EDE-Q scores and BMI, %EBMIL and age are illustrated in Supplemental Digital Content 3. Baseline total EDE-Q correlated negatively with baseline BMI

(r = −0.2, P = 0.022), whereas at 1-year, the direction of the correlation tended to be positive (r = 0.15, P = 0.082). EDE-Q did not correlate significantly with age and correlated negatively only at the threshold of significance with %EBMIL. Nevertheless, delta EDE-Q correlated positively with 1-year %EBMIL (r = 0. 21, P = 0.016).

Prediction model of healthy EDE-Q scores at 1-year

Prior to performing logistic regression on the database of the entire patient cohort (n=234), the following missing data were accounted for by multiple imputations: healthy or unhealthy EDE-Q score at 1-year (n=99), BMI at 1-year (n=32), %EBMIL at 1-year (n=32), age (n=4), presence or lack of any postoperative complications (n=1). Results of the logistic regression on predictors of "healthy" 1-year total EDE-Q outcome are listed in Supplemental Digital Content 4. Only baseline EDE-Q "healthy" status was found to significantly predict a healthy EDE-Q score at 1-year after BS (OR 6.7, 95% CI 1.18 – 38.14, P = 0.04). All other parameters of our prediction model had no statistically significant predictive value for the achievement of a healthy EDE-Q score 1-year after BS.

Discussion

Pathologic eating symptoms, as measured by the EDE-Q, were very frequent among BS candidates. However, in most cases, pathologic eating symptoms normalized during the first year after BS. The achievement of a "healthy" eating behavior could not be predicted by baseline parameters (age, sex, BMI, comorbidity status or type of BS [RYGB or SG]), or by postoperative outcomes, such as 1-year %EBMIL or presence of surgical complications during the first postoperative month. The only significant predictor of "healthy" postoperative EDE-Q was a "healthy" EDE-Q score at baseline. Thus, in BS candidates with an unhealthy EDE-Q, we were unable to identify any factors predicting the normalization of their EDE-Q scores at 1-year. However, as there was a significant positive correlation between %EBMIL and delta

EDE-Q at 1-year, we cannot rule out that postsurgical weight loss at least partly contributed to the amelioration of eating disorders symptoms. Nutritional counselling might also have assisted in the observed improvement of EDE-Q scores after BS [30]. However, every patient in Switzerland has to undergo two years of unsuccessful conservative treatment including intense nutritional counselling before formally qualifying for BS [15]. Thus, the high incidence of pathological EDE-Q scores at baseline may indicate a high level of unresponsiveness to nutritional counselling in the study population.

The results of the present study are in line with previous studies investigating associated changes in prevalence of binge eating and weight loss following gastric banding [8]. Our findings are in further agreement with *Conceição et al*., who reported that preoperative EDE-Q scores did not correlate with weight loss at two years after gastric banding and RYGB. The same authors further found that problematic eating in the postoperative phase predicted worse weight loss trajectories [31]. *Nasirzadeh et al.* also found that the presence of eating disorders, especially binge eating, at 1 year after BS predicted future weight regain [32].

Together with the available literature mentioned above, our data emphasizes the need for systematic assessment of eating behaviors during routine bariatric follow-up. In this context, additional live or internet-based behavioral and/or psychological interventions targeting patients with pathologic eating patterns have been recommended [31].

Bariatric patients' quality of life is known to be influenced by BMI [33], the extent of weight loss [34] and weight regain [35], and by the persistence of obesity-related diseases [33]. We therefore hypothesized that these factors, along with age, sex, type of procedure and surgical complications might interfere with the postoperative improvement of eating disorders. Surprisingly, none of these parameters influenced significantly the odds of achieving a healthy postoperative EDE-Q outcome, suggesting that BS has a uniform beneficial effect on eating behavior across very different patient subgroups. Examination of individual EDE-Q question

scores showed some marked differences between subgroups, however, these specific questions were rather connected to weight-related anxiety and body shape perception than to the eating behavior itself.

The present study has a number of limitations that have to be considered when interpreting the results. *First*ly, eating behavior psychopathology was measured *indirectly*, by a self-reported questionnaire, which is particularly prone to recall bias and potentially also to the biasing effect of body shame of obese patients. Nevertheless, the EDE-Q has been validated in different languages, both in paper and online format [36, 37]. Ideally, pre- and postoperative eating behavior should be measured *directly*, for example by a wearable system that detects eating episodes or by video recordings of a body-camera worn by the patients over weeks [38]. At the price of ethical and methodological obstacles, videotaping would have enabled the measurement of the frequency and type of food intake, as well as how and when the nutrients were consumed (snacking, binge eating, night eating, vomiting, "picky" eating, etc.). *Secondly*, the EDE-Q was designed for the assessment of general eating disorders [39], and BS-specific eating pathologies such as dumping, rumination, spitting out food, food "plugging" or night-eating [12, 40-42] do not fall under its scope, and thus were not assessed. This might have resulted in an underestimation of the frequency of postoperative *de novo* eating disturbances. *Thirdly*, the 1-year follow-up might have been too short. Several studies reported long-term recidivism in eating pathologies, notably in those patients who experience weight regain [32, 43]. *Fourthly*, the majority of patients in our cohort were female and underwent RYGB, therefore the overall outcomes (EDE-Q scores, comorbidity resolution, surgical complications) are less generalizable to males and to patients who undergo SG. *Fifthly*, although we failed to identify baseline differences between patients with and without available follow-up, our analyses may have been biased by the "missing not at random" effect [44].

Despite its limitations, this study has several important strengths, particularly the complete 1-year follow-up in a relatively large BS patient cohort that received standardized single-institutional perioperative care. The pathways that link the postbariatric neurophysiologic changes and the improvements in eating behavior are currently not entirely understood [36, 37, 39, 44, 45]. The presented findings might generate further hypotheses on the amelioration of eating behavior after BS and may foster the design of future studies, including assessment of "signature" postbariatric eating disorders [46] and *direct* measurement of pre- and postoperative food intake [47].

Conclusions

BS seems to promote a significant improvement of self-reported eating behavior disorders during the first postoperative year. The achievement of these positive results is independent of age, sex, weight loss, obesity-related comorbidity status, surgical technique or surgical complications. The only predictor of healthy EDE-Q score at 1-year is a healthy EDE-Q score at baseline. Future studies are needed to clarify the underlying neuropsychologic mechanisms that drive the changes in eating behavior following BS, including validated BS-specific pathological eating behavior questionnaires and direct measurement of eating behavior.

Compliance with Ethical Standards

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval and Informed Consent

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and cantonal research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The **blinded*

Ethics Committee approved the study (nr: 2016-00022). For this type of study, formal consent is not required, as it was a retrospective study.

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Tables

Table 1. Characteristics of the study population with available 1-year follow-up (n = 135). *M: mean, SD: standard deviation CI: confidence interval. * Effect size for continuous variables: Cohen's d; effect size for proportions based on binary outcomes: odds ratio*

	Baseline	1-year	Mean of differences	Effect size* (95% CI)	P
Age at baseline, M ± SD	40.29 ± 12.07				
Female / male (n)	97 / 38				
Operation: RYGB / SG (n)	120 / 15				
BMI (kg/m2), M ± SD	43.97 ± 6.53	26.69 ± 5.4	14.29	3.4 (3 - 3.7)	<0.001
Weight (kg), M ± SD	124.23 ± 26.01	83.82 ± 19.41	40.33	2.9 (2.6 - 3.3)	<0.001
Hip (cm), M ± SD	122.4 ± 44.5	114.6 ± 89.76	7.05	0.07 (-0.17 - 0.31)	0.41
Waist (cm), M ± SD	112.37 ± 41.36	95.09 ± 16.77	16.77	0.45 (0.2 - 0.7)	<0.001
Hip/waist ratio, M ± SD	1.097 ± 0.13	1.218 ± 0.93	0.132	-0.13 (-0.4 - 0.12)	0.152
Absence of obesity-related comorbidity (%)	12.59	44.44	31.85	5.5 (3 - 10)	<0.001
Type 2 diabetes mellitus (%)	22.22	6.66	15.56	4 (1.82- 8.8)	<0.001
Arterial hypertension (%)	36.3	14.81	21.48	3.27 (1.81 - 5.91)	<0.001
Sleep apnoe syndrom (%)	30.37	12.59	17.77	3 (1.6 - 5.7)	<0.001
Dyslipidemia (%)	24.44	8.89	15.55	3.3 (1.6 - 6.7)	<0.001
Ischemic heart disease (%)	7.41	5.93	1.48	1.27 (0.5 - 3.3)	0.662
Joint pain (%)	65.18	28.89	36.3	4.6 (2.7 - 7.7)	<0.001
Gastro-esophageal reflux disease (%)	40	11.11	28.89	5.3 (2.8 - 10.1)	<0.001
Depression (%)	23.7	19.26	4.44	1.3 (0.7 - 2.3)	0.392

Table 2. 30-day surgical complications according to the Clavien-Dindo classification in the study population with available 1-year follow-up (n = 135) [18].

Grade	n	%	Description
I	7	5.19	Hypocalcemia, hypoesthesia of the thigh, minor bleeding
II	11	8.15	Perigastric hematoma, wound infection, pneumonia, urinary tract infection, bleeding, peripheral oedema
IIIa	17	12.59	Endoscopic dilation of anastomotic stenosis, endoscopic treatment of bleeding at gastrojejunostomy, CT-guided pleural punction
IIIb	3	2.22	Liver hematoma post-liver biopsy, intra-abdominal bleeding
IVa	0	0	
IVb	0	0	
V	0	0	
Total	38	28.15	

Table 3. Eating Disorder Examination-Questionnaire (EDE-Q) scores in total and in subscales at baseline and at 1-year after bariatric surgery in patients with available 1-year follow-up (n = 135). P values show the result of paired t-tests. *SD: standard deviation CI: confidence interval*

		Mean ± SD	Mean of differences	Cohen's d (95% CI)	P
Total	Baseline	3.24 ± 1.3	1.80	1.23 (0.96 -1.49)	<0.001
	1-year	1.44 ± 0.95			
Restrain	Baseline	2.71 ± 1.5	1.25	0.68 (0.43 - 0.93)	<0.001
	1-year	1.46 ± 0.95			
Eating Concern	Baseline	1.57 ± 1.38	0.89	0.6 (0.35 - 0.84)	<0.001
	1-year	0.68 ± 1.02			
Weight Concern	Baseline	3.73 ± 1.22	2.02	1.2 (0.94 - 1.46)	<0.001
	1-year	1.71 ± 1.41			
Shape Concern	Baseline	4.28 ± 1.3	2.07	1.22 (0.96 - 1.48)	<0.001
	1-year	2.2 ± 1.45			

Figures

Figure 1. Eating Disorder Examination-Questionnaire total score at baseline and at 1-year after bariatric surgery in patients with available 1-year follow-up (n = 135). Red dots: individual cases, green line: cut-off for healthy < 2.5. The P value shows the result of paired t-test statistic.

Supplemental Digital Contents

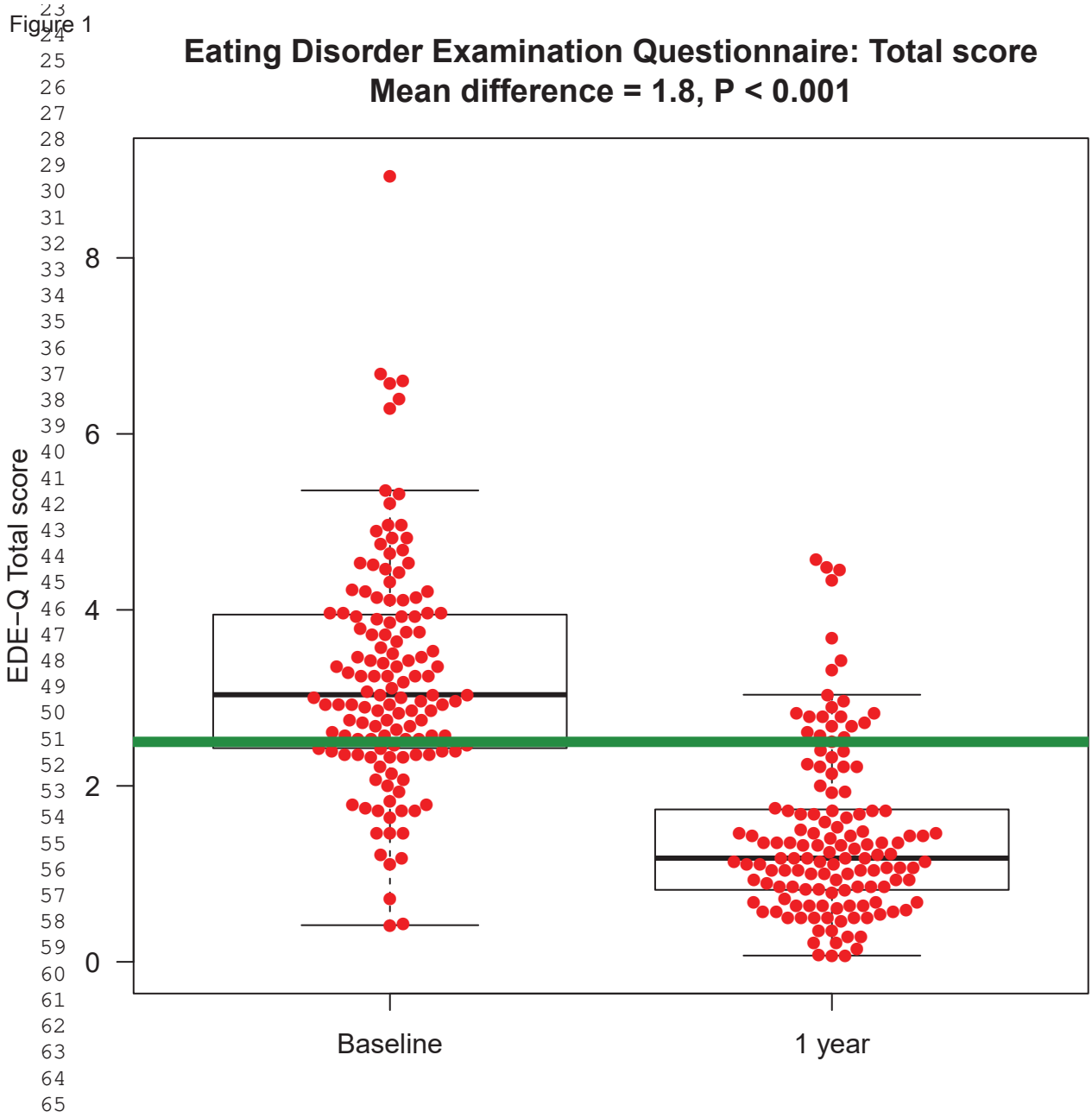
Supplemental Digital Content 1. Comparison of baseline characteristics of patients with and without available 1-year follow-up (FU) for the Eating Disorders Examination Questionnaire (EDE-Q). *M: mean, SD: standard deviation.*

Supplemental Digital Content 2. Body mass index (BMI), hip/waist ratio and Eating Disorder Examination (EDE) Questionnaire scores within sex, age and %excess BMI loss subgroups. P values show the result of independent sample t-tests after Levene's test for equality of variances.

Supplemental Digital Content 3. Pearson's linear correlations with 95% confidence interval between: A. Total Eating Disorder Examination-Questionnaire (EDE-Q) and BMI at baseline, B. Total EDE-Q and BMI at 1-year, C. Total EDE-Q at baseline and 1-year %EBMIL, D. Total EDE-Q at 1-year and %EBMIL at 1-year, E. Delta EDE-Q (Baseline – 1-year) and %EBMIL at 1-year, F. Total EDE-Q at 1-year and age at baseline.

Supplemental Digital Content 4. Logistic regression to identify parameters that might influence the healthy outcome of the 1-year Eating Disorder Examination Questionnaire score (summa < 2.5). The analyses were performed on the entire patient cohort (n=234) following multiple imputations of missing data. For leveled categorical variables (% Excess BMI loss [EBMIL] and age), the lowest groups were used as reference.

Figure 1


Eating Disorder Examination Questionnaire: Total score
Mean difference = 1.8, P < 0.001
EDE−Q Total score
0
2
4
6
8
Baseline
1 year

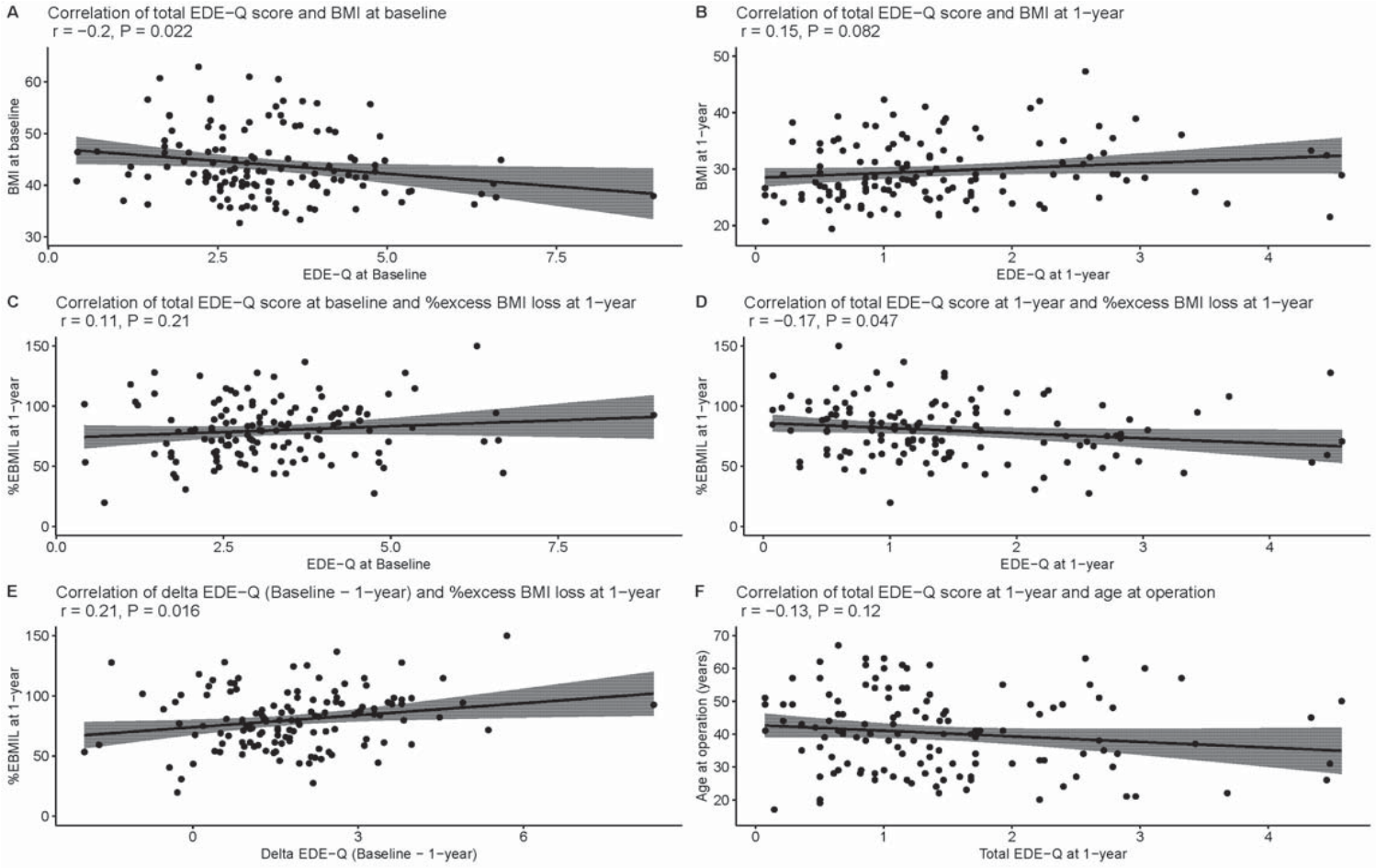
Supplemental Digital Content 1. Comparison of baseline characteristics of patients with and without available 1-year follow-up (FU) for the Eating Disorders Examination Questionnaire (EDE-Q). *M: mean, SD: standard deviation.*

Patient characteristics at baseline	With 1-year FU (n=135)	Without 1-year FU (n=99)	Mean of differences	P
EDE-Q Total, M ± SD	3.24 ± 1.31	3.60 ± 1.60	0.36	0.07
Age, M ± SD	40.29 ± 12.07	42.74 ± 12.08	2.44	0.13
Female / male (n)	97 / 38	71 / 28	0	1
Operation: RYGB / SG (n (%))	120 / 15 (88.8)	78 / 21 (71.71)	17	0.053
BMI (kg/m2), M ± SD	43.97 ± 6.53	42.03 (6.26)	1.94	0.02
Weight (kg), M ± SD	124.23 ± 26.01	117.33 (24.21)	6.9	0.04
Hip (cm), M ± SD	122.4 ± 44.5	121.98 ± 39.5	0.37	0.95
Waist (cm), M ± SD	112.37 ± 41.36	113.16 ± 37.75	0.79	0.89
Hip/waist ratio, M ± SD	1.097 ± 0.13	1.09 ± 0.13	0.01	0.58
Absence of obesity-related comorbidity (%)	12.59	8.1	4.49	0.37
Type 2 diabetes mellitus (%)	22.22	15.3	6.92	0.17
Arterial hypertension (%)	36.3	39.4	3.1	0.65
Sleep apnoe syndrom (%)	30.37	37.4	7.03	0.4
Dyslipidemia (%)	24.44	16.2	8.24	0.22
Ischemic heart disease (%)	7.41	8.1	0.69	1
Joint pain (%)	65.18	73.7	8.52	29
Gastro-esophageal reflux disease (%)	40	40.4	0.4	0.95
Psychologic disease (%)	23.7	31.3	7.6	0.16

Supplemental Digital Content 2. Body mass index (BMI), hip/waist ratio and Eating Disorder Examination (EDE) Questionnaire scores within sex, age and excess BMI loss subgroups. P values show the result of independent sample t-tests after Levene's test for equality of variances.

		Sex				**Age > 40**				**Excess BMI Loss > 75% at 1-year**			
		P	**Mean difference**	**95% Confidence Interval of the Difference**		**P**	**Mean difference**	**95% Confidence Interval of the Difference**		**P**	**Mean difference**	**95% Confidence Interval of the Difference**	
			+ = females higher	**Lower**	**Upper**		**+ = younger higher**	**Lower**	**Upper**		**+ = 1-year %EBMIL<75 higher**	**Lower**	**Upper**
BMI	**Baseline**	**0.006**	**-3.390**	**-5.780**	**-1.000**	0.942	0.080	-2.120	2.280	**0.000**	**7.243**	**5.314**	**9.171**
	1-year	**0.017**	**-2.453**	**-4.452**	**-0.455**	0.062	-1.720	-3.530	0.090	**0.000**	**8.705**	**7.557**	**9.854**
Hip/waist ratio	**Baseline**	**0.000**	**0.117**	**0.073**	**0.162**	**<0.001**	**0.080**	**0.037**	**0.122**	0.686	-0.009	-0.054	0.036
	1-year	0.210	0.227	-0.129	0.583	0.516	-0.105	-0.425	0.214	0.168	-0.223	-0.543	0.096
EDE Total	**Baseline**	**0.027**	**0.562**	**0.064**	**1.060**	0.907	-0.027	-0.481	0.427	0.471	-0.167	-0.622	0.289
	1-year	0.901	-0.023	-0.384	0.338	0.060	0.306	-0.013	0.625	**0.019**	**0.382**	**0.064**	**0.700**
EDE Restrain	**Baseline**	0.585	0.156	-0.408	0.721	0.813	-0.061	-0.567	0.446	0.455	-0.192	-0.700	0.315
	1-year	**0.028**	**-0.603**	**-1.140**	**-0.067**	0.240	-0.290	-0.775	0.196	**0.022**	**0.562**	**0.083**	**1.041**
EDE Eating Concern	**Baseline**	0.210	0.332	-0.190	0.853	0.569	0.135	-0.334	0.605	0.575	-0.134	-0.605	0.337
	1-year	0.402	0.164	-0.221	0.548	**0.039**	**0.359**	**0.018**	**0.699**	0.122	0.280	-0.076	0.636
EDE Weight Concern	**Baseline**	**0.006**	**0.643**	**0.189**	**1.097**	0.553	0.126	-0.292	0.543	0.539	-0.131	-0.550	0.289
	1-year	0.779	0.076	-0.458	0.610	0.424	0.194	-0.284	0.671	**0.013**	**0.596**	**0.126**	**1.066**
EDE Shape Concern	**Baseline**	0.065	0.464	-0.030	0.959	0.395	0.193	-0.254	0.640	0.456		-0.619	0.279
	1-year	0.980	0.007	-0.543	0.557	0.092	0.419	-0.069	0.906	0.122	0.386	-0.104	0.876

Supplemental Digital Content 3. Pearson's linear correlations with 95% confidence interval between: A. Total Eating Disorder Examination-Questionnaire (EDE-Q) and BMI at baseline, B. Total EDE-Q and BMI at 1-year, C. Total EDE-Q at baseline and 1-year %EBMIL, D. Total EDE-Q at 1-year and %EBMIL at 1-year, E. Delta EDE-Q (Baseline – 1-year) and %EBMIL at 1-year, F. Total EDE-Q at 1-year and age at baseline.



Supplemental Digital Content 4. Logistic regression model to identify parameters that might influence the healthy outcome of the 1-year Eating Disorder Examination Questionnaire score (summa < 2.5). The analyses were performed on the entire patient cohort (n=234) following multiple imputations for missing data. For leveled categorical variables (% Excess BMI loss [EBMIL] and age), the lowest groups were used as reference.

	P	Odds ratio	95% Confidence Interval for Odds ratio		Standard Error
			Lower Bound	Upper Bound	
EDE healthy at baseline	**0.04**	**6.70**	**1.18**	**38.14**	**0.89**
BMI at baseline	0.77	1.02	0.88	1.19	0.08
BMI at 1-year	0.37	0.88	0.66	1.17	0.15
%EBMIL at 1-year = 50 - 75%	0.71	0.60	0.04	8.44	1.35
%EBMIL at 1-year = 75 - 100%	0.87	0.75	0.03	22.26	1.73
%EBMIL at 1-year >100%	0.63	0.34	0.00	26.61	2.22
Female sex	0.73	0.83	0.29	2.39	0.54
Age = 30 - 50 years	0.71	1.34	0.29	6.21	0.78
Age > 50 years	0.31	2.02	0.53	7.74	0.69
Roux-en-Y gastric bypass	0.20	0.38	0.09	1.62	0.74
Absence of obesity-related comorbidities at baseline	0.24	0.43	0.11	1.74	0.71
Absence of obesity-related comorbidities at 1-year	0.58	1.51	0.36	6.41	0.74
Absence of surgical complications	0.69	1.31	0.35	4.95	0.68